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THE TELEGRAPHIC JOURNAL

AND

ELECTRICAL REVIEW.

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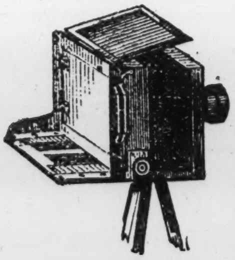

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THE TELEGRAPHIC JOURNAL.
VOL. IV.—No. 91.

GALVANIC EXPANSION.

SOME time ago M. Edlund drew the inference from some experiments, that a metallic wire, through which flows a galvanic current, is more elongated than would be due simply to the rise of temperature produced by the current. The whole elongation consisted of two parts, one of which was calculable from the rise of temperature of the wire, while the other was directly dependent on the strength of the current, and increased rapidly with it. This latter part he named *galvanic expansion.*

Three methods of observation were adopted :—1. A current was sent through a wire; and the elongation *a* and resistance *b* were measured. Then the expansion of the wire by heat, and the relation of the resistance to temperature, were determined. It was then easy to ascertain what temperature the wire had, when its resistance was *b;* and consequently, also, whether the measured elongation *a* was exclusively due to rise of temperature or not. Now, the elongation was always found greater than could be explained by rise of temperature. 2. The wire was heated in an air-bath, and its length and galvanic resistance were observed at the temperature produced. After it had cooled, a current was sent through it, and the strength of this gradually increased, till the resistance was as great as when it had been placed in the air-bath; then the length of the wire was again measured. The length was always found greater in the latter case than in the former, though the resistance, and so the temperature, were the same in both cases. 3. A current was sent through the wire enclosed in eider-down (so as to have little cooling); and the length and resistance of the wire were then measured. Then the down was removed, and the air was set in motion about the wire with a ventilator, which caused much cooling. The strength of the current was then so adapted, that the resistance of the wire was just the same as in the previous case, and the length of the wire was again measured. (The current-strength had naturally to be stronger in the latter case). Now, the length of the wire was always found greater in the second case than in the first, though in both it had the same temperature. Thus, all three methods appeared to give the same result.

Some objections were raised by M. Wiedemann to M. Edlund's conclusions, and, accordingly, M. Streintz was led to study the phenomena by a different method. He first determined carefully the solidifying and the melting point of stearine, finding the former 53·°4 C and the latter 55·°5 C. The wire to be examined was coated, in position, with a very thin layer of stearine; a current was sent through it, and the strength was gradually increased till the stearine began to melt; then the elongation of the wire was measured. On comparing this elongation with that of the wire when heated in an air-bath to the same temperature, the former was found to be the greater, thus confirming M. Edlund's deductions.

M. Wiedemann, without rejecting these absolutely, has objected, *inter alia*, that it was difficult to determine exactly the temperature of the interior of the wire. In reply (*Pogg. Ann.*, No. 5, 1876) M. Edlund, taking his position on the known laws of propagation of heat and the velocity of cooling in the wires experimented with, calculates that the central temperature of the wires can only be superior to the superficial temperature by a very small fraction of a degree; whereas to account for the facts observed on the other hypothesis, it would be necessary to suppose that the mean temperature of the wire surpasses the superficial temperature by several degrees. We cannot here give the details of M. Edlund's argument.

Galvanic expansion has the property of not immediately disappearing with the cessation of the galvanic current; it decreases gradually, much after the same law as expansion through heat. From this fact, both M. Edlund and M. Streintz draw the inference that it must be produced by molecular oscillations, which disappear in proportion as they communicate their *vis viva* to the matter and the ether by which the wire is surrounded. M. Edlund further adopts M. Streintz' view, that the heat produced by the current is polarised, the oscillations taking place chiefly in the direction of the current. Such a hypothesis is simple, and appears to account satisfactorily for the phenomenon.

Whatever promotes the communication of the oscillations to the surrounding medium, must evidently diminish the galvanic expansion. Now, this has been confirmed by some experiments recently made by Dr. Exner, who, however, argues from them against the existence of galvanic expansion. He operated by cooling the conducting wire, through which the current was passing, in cold water. The galvanic expansion therewith disappeared, so that hardly a trace of it remained. That this should be the result of such experiments seems quite to harmonise with the view of M. Edlund, above described.

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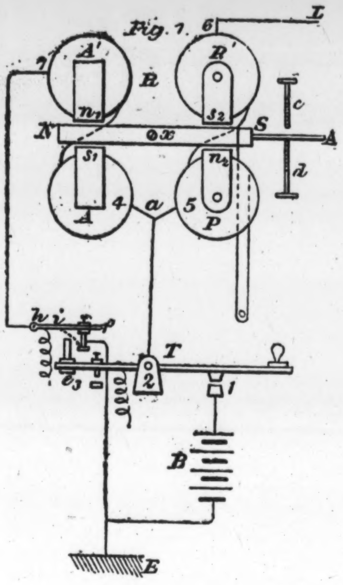


Zinc to earth

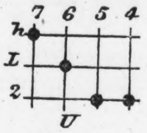


Fig. 2

Copper to earth

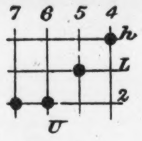
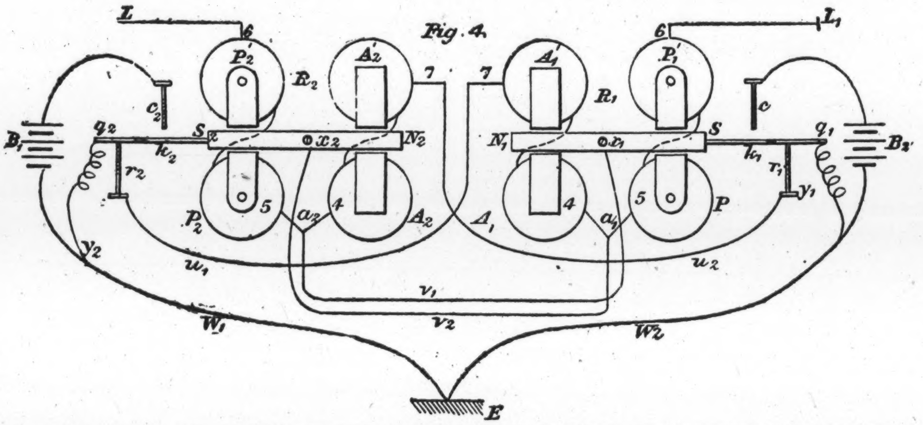


Fig. 3.



IN the first of the above figures (which we borrow from *Dingler's Polytechnisches Journal*) illustrating this system, 1, 2, and 3 represent the working contact, the axis, and the back contact, respectively, of an ordinary Morse key, on which, at its further end, an insulator *e* is fixed, which, on pressing down the handle, raises the lever *h f* from the contact *i*, connected with earth E. The line-battery B is inserted between 1 and E. Of the two corresponding stations, one has the copper pole, the other the zinc pole of the battery to earth, so that the currents of both are in the same direction. The relay R contains two pairs of coils A, A′, and P, P′; while A and A′ form an ordinary horse-shoe electro-magnet (with unmagnetic core), the cores of the horse-shoe electro-magnet P, P′, as in the Hughes type-printer, stand on the poles of a permanent horse-shoe magnet, and are so induced by it, that in P a north pole n_2, and in P′ a south pole s_2 is produced. With the aid of an iron piece the magnet can be pushed one way or another so as to adapt the magnet strength to the current strength. Between the four poles of the relay is the magnetic bar N S, the continuation of which, *k*, plays between the set screws *c* and *d*, and on its application to the working contact *c* closes the local battery. The coil-end 6 is connected with the telegraph line L, the end 7 with the lever *h*, and the key axis 2 with the point *a* in which the two coil-ends 4 and 5 unite.

In order that the relay may be inserted suitably to the direction of current, each station is provided with a commutator U (figs. 2 and 3) with 3 and 4 plates. To the four vertical plates are connected the four coil-ends 4, 5, 6, and 7; to the three horizontal plates the lever *h*, the line L, and *a* or the key axis 2. The station which has zinc to earth, arranges the stops as in fig. 2, so as to connect 4 and 5 with *a* and 2, 7 with *h*, and 6 with L. The station with copper to earth arranges as in fig. 3, connecting 6 and 7 with *a* and 2, 5 with L, and 4 with *h*.

When neither key is depressed, and therefore no current passes through the line, the north pole N of the armature, if equally distant from the two cores in A and A′, is attracted equally by them; but if unequally distant, it is attracted most strongly by the core nearest to it. The south pole S, on the other hand, is repelled by the south pole s_2 in P′, and attracted by the north pole n_2 in P, and therefore the armature takes the position with k on the rest-screw d.

If only one key T, is depressed, and the battery B closed at 1, at the same moment that e raises the lever $h\ f$ from i, then at the sending station the current goes from 1 to 2 and a, only through the coils P and P′, and into the line L; thus in the cores of the electro-magnets P P′ the magnetism is neutralised, but the armature is held by the core nearer to it in its position at d. At the receiving station, on the other hand, the current coming from L passes successively through the coils P and P′, A and A′, and then goes over $h\ f$ to earth E; thus not only is the magnetism of the cores in P and P′ destroyed, but the cores of A and A′ are magnetised, a south pole s_1 being developed in A, and a north pole n_1 in A′. Hence the north pole N of the armature is repelled from n_1 and attracted by s_1, and k is brought against the working contact-screw c.

If both keys, lastly, are pressed down at once, the strengthened current goes at both stations only through the coils P and P′, and it not only destroys in their cores the magnetism present, but developes in them contrary poles; P thus becomes southly magnetic, and P′ northly magnetic. The south pole accordingly moves from P to P′, k becomes applied to c and closes the local battery.

If $h\ f$ is raised from i somewhat after the instant at which the battery B is closed, the current goes for a time at the sending station also through A and A′; not in the same direction as a current from the other station passes through A and A′, but in the opposite; hence in this case the home-relay will not speak, if this is free from a current; if, on the other hand, it is traversed by the current of the other station, the action of this in A A′ and the added action of the weak branch of the home-current going through P P′ will be easily overcome by the much stronger branch of this current passing through A A′, and so the arriving signal be spoiled. If, on the other hand, $h\ f$ be raised from i somewhat before the key lever closes the working contact, then during this time no way to earth would remain for the current coming by the line from the other station. In this case also, therefore, each movement of the key might spoil the coming signal, and this is as much to be guarded against as a short passage of current through A A′ in the previous case. Where, however, it is a case of very small intervals of time, the circumstance that neither the action of the branch current in A A′ occurs instantly, nor, on cessation of the current in P P′, has the former magnetism again its original strength, may help over the difficulty.

The coils of the electro-magnets A A′ should have more windings than the coils of P P′, that with earth connection of the line, the action of the weaker arriving current at A A′ may not also have to overcome the not quite perfect demagnetisation of the core of P P′ produced by it.

In using the arrangment as translator, the continuation k of the armature lever of the duplex relay R is furnished with a further prolongation q insulated from k, and this is opposite the set-screw r as contact-screw. The zinc poles of the two batteries B_1 and B_2 (fig. 4) of the translation station are connected to earth E by the wires w_1 and w_2; their zinc poles applied to the contact screws c_2 and c. The continuations q_1 and q_2 also are connected, by thin spirally-wound wires, with the earth. From the ends 7 of the coils A'_1 and A'_2, go wires u_1 and u_2 to r_2 and r_1; from the axes x_1 and x_2 of the armature N_1 S and N_2 S_2 wires v_1 and v_2 to the points of union a_2 and a_1 of the coil ends 5 and 4. To the ends 6, lastly, come, at P'_1 the line L_1, at P'_2 the line L. The armature-lever has, for the same reasons as before, as small a space to play in as possible between the contact-screws c and r.

If now a current comes from L, it passes through P'_2 and P_2, A_2 and A'_2, goes from 7 in the wire u_2 to r_1, q_1, y_1, and in w_2 to earth E; the relay R_2 thus speaks, q_2 removes from r_2 and k_2 is applied simultaneously to c_2; accordingly the current from B_1 now goes from the zinc pole in the wire w_1 to earth E, and from the copper pole over c_2, k_2, x_2, through the wire v_2 to a_1, and from here only through P_1 and P'_1, over 6 into the line L_1, but without the relay R_1 speaking, and interrupting the passage between r_1 and q_1 for the line current coming from L.

RESEARCHES ON THE ELECTRIC LIGHT.

THE brilliant phenomena presented by the electric discharge in rarefied gases have not hitherto been sufficiently investigated for one to be able to tell beforehand, from the conditions of experiment, the character of the phenomenon, the form and colour of the light. This deficiency in our knowledge of the laws of such discharge appears to be partly met by a series of experiments that have been made by M. Goldstein, and described by him to the Berlin Academy at one of its recent *séances*.

The most important result of the whole investigation is contained in the following proposition:—The supposed existence of two kinds of conduction in rarefied gases, corresponding to the so-called positive and negative lights, can as little be accepted as that the process of discharge, as represented in the positive light, is similar to metallic or electrolytic conduction. *Positive and negative lights are rather of the same kind;* their differences are only those of degree; and it is possible to obtain a continuous series of intermediate members between them.

This conclusion is supported by the following facts:—

With exception of the peculiar stratification of the cathode-light, the author has been able, with certain conditions of experiment, to give the positive light all those properties which previously seemed to be peculiar to the negative light, and to render it opposite in character to the positive. Examples are, the colour and spectrum of the cathode-light, the power of becoming arranged in magnetic curves under the influence of a magnet, that of exciting fluorescence, and the formation of the dark space. Denoting the circumference of section of the tube in the direction towards the negative electrode, as its "negative circumference," he sums up his experimental results in the following way:—Whether the discharge at a point between the dark space and the anode will occur as positive or negative light depends on the course of *change of section* in the negative circumference of the place in question. If the ratio of two successive sections there is either equal to 1, or if the width increases in the direction of the current, the discharge occurs as positive light. If, however, there is a rapid and and great decrease of section in the direction of the current, the discharge appears from the narrowest part some distance towards the anode as negative light; throughout a greater length, and agreeing the more in properties with the cathode-light, the further the section-ratio is from 1. By varying this section-ratio, one may produce at will intermediate forms between positive and negative light. With regard to the remaining extent of the discharge between the dark space and the cathode, negative light always appears in this, that is, the light which, spreading out from the cathode, has hitherto been known alone as negative light.

M. Goldstein proceeds to a consideration of the properties hitherto recognised as the most certain distinguishing marks of the positive and negative lights. Many investigators have pointed out the remarkable differences of the spectra of positive and negative light, especially in the cases of nitrogen, air, and hydrogen. M. Goldstein has examined these gases, and he has succeeded, by very great rarefaction, or by strengthening the intensity of discharge, in transforming the spectrum of the positive light of tubes of any form, filled with air, nitrogen, or hydrogen, into a spectrum of the cathode-light. The puzzling observations of MM. Reitlinger and Kuhn on the spectra of negative electrodes are fully explained by the fact, that the experiments were made with a tube whose gaseous contents were absorbed by the electrodes during passage of the current, so that a very great rarefaction was produced. M. Goldstein, in the course of his experiments, has repeatedly met with such tubes.

Since Plucker's time it has been believed that while the negative light under magnetic influence becomes arranged in the magnetic curves, the stratified positive light is simply deflected like a flexible conductor, according to Ampère's law. M. Goldstein found, on the contrary, that this positive light behaves under influence of the magnet exactly like the negative, and that even a less magnetic force is required to bring the positive light into form of the magnetic curves. For this it is only necessary that the discharge-vessel have such a form and position with reference to the magnet, that the curves of the magnetised light can fall generally into the free space of the vessel.

The form assumed by the electric light of the whole discharge under influence of the magnet seems dependent on the amount of electricity passing at once.

Further proofs of the homogeneousness of the positive and negative electric light are afforded by observations on the stratification of the electric light.

The stratification of the positive light occurs in a connected series of forms, of which one terminal member shows a succession of thin light discs pressing closely on one another, but separated by almost non-luminous intervals, while the other terminal member presents long, continuous light columns, almost a hundred-fold thicker than the other forms—joined directly with each other, but their limits indicated by a different degree of brightness. In one and the same tube the first form appears with the greatest density with which the phenomenon is obtained, the second with the greatest rarefaction. Each layer has, near its negative limit, a maximum of brightness, from which the intensity gradually diminishes towards the positive side. Further, the different parts of a layer show, not unfrequently, quite different colours, *e.g.*, red and blue, yellow and blue, and the like. The coloration of the layer varies with varying density.

A closer investigation of the behaviour of the layers led to the result, that the individual positive layers, which are present simultaneously in the same equally wide tube, are not of equal value. They rather show differences in density, curvature, mobility, and, most obviously, in colour. These differences of colour of the individual layers compared with each other vary with the density of the gas, so that a very great variety in the phenomenon is the result.

It is erroneous, therefore, to ascribe, as has hitherto been common, a determinate colour to the discharge in a determinate gas. The discharge may, in one and the same gas, present a whole series of entirely different colours; and, accordingly, the spectra also must present differences.

If we denote as the "ordinal number" *(Ordnungs Zahl)* that number which indicates how many a particular layer counts from the corresponding negative light, the observations lead to the conclusion that the character of any layer is a *function of its ordinal number*. Thus the stratification of the positive light in all gases examined under conditions otherwise similar is sharper, and more completely formed, the nearer it is to the negative end. This proposition holds good also for tubes of any composite form.

The stratification does not extend over the whole column of the positive light. The light is divided throughout a greater extent into layers the greater the diameter of the tube. If a tube is composed of several communicating pieces, each of these pieces behaves in general like a separate tube, which has its (secondary) electrodes at the two entrance-apertures. Behind each secondary negative pole of the kind the stratification is resumed with new distinctness. This fact renders it possible to determine beforehand all the phenomena which a tube of any complex form, with any densities, will present, whenever one knows the phenomena which correspond to tubes of the form of its constituent pieces (cylindrical, ball-shaped, ellipsoid, &c., discharge-vessels).

If we divide a cylinder from the cathode onwards into several similar sections, which communicate with each other by narrow apertures, there occur in each individual section an exactly similar series of light-layers; the colours and forms of each section are repeated in the same series and the same dimensions with absolute agreement. Each layer of any section has in every other section an exactly corresponding layer; these are the layers of the separate sections which have the same ordinal number.

By providing a sufficient number of strong and rapid changes of section, it is further possible to obtain, as often as one likes, in a tube, the dark space commonly observed in the neighbourhood of the cathode, and with suitably-chosen dimensions of tube one may cause the discharge to occur absolutely without light through any length of tube.

The transition of the negative light into the positive can be easily effected by making the amount of change of the internal section ever smaller. One then sees how the light-system which (at the previous narrowing) presents a tuft of negative secondary light, passes over by intermediate forms into a distinct positive light, while the dark space between negative and positive light corresponds to the interval between the light maxima of two successive layers. The same result is obtained by a single narrowing, with variable density. If this is diminished, one sees the secondary negative light-tuft, which reaches out of the narrow tube into the wide one, break away, go into the wide tube, and become its first positive layer. Hence M. Goldstein draws the following inference:—Each individual layer of the positive light is a form corresponding to the former so-called negative or cathode light, and the stratified positive light consists properly of a succession of systems of negative light. And, conversely, we are warranted in regarding each system of negative light, and so, *e.g.*, the cathode light in its essence as a layer of the positive light.

With the aid of this conception of the cathode light along with the proposition that the interval between two successive light-layers, counted from the negative pole, in a discharge-length of regular section, with given density of gas and intensity of discharge, is a constant quantity, M. Goldstein finally explains a whole series of phenomena presented by the electric light. It may only be mentioned here that the layer-interval, which, above all, determines the phenomena of the discharges in rarefied gases, is independent of the length of the tube, and, on the other hand, it depends very essentially on the cross dimensions of the discharge-vessel, as well as on the density of the gas.

TORPEDOES AND TORPEDO WARFARE.*

The importance of having a well-constituted torpedo system, as a means of defence against the approach of an enemy by sea or land, is now so fully recognised by all established Governments having a sea-board, or possessed of navigable rivers, that large sums of money are annually voted for experimental purposes alone. Thus England in 1873 spent upwards of £50,000, while, no doubt, last year a still larger outlay would necessarily be made to meet the cost of the "Oberon" experiments carried out at Portsmouth, where a large vessel, specially fitted up with armour to represent an iron-clad of the heaviest kind, has been destroyed by a preconcerted series of experiments, simply to elicit full information respecting the enormous power of this terrible weapon. Again, it is within the knowledge of the writer that in 1873, the United States of America purchased from one firm alone torpedo cable to the extent of £60,000. And this in a time of peace!

France, Germany, Russia, Sweden, and even the petty Republics of South America, are all spending money freely in constructing and perfecting their systems of torpedo defence.

The earliest authentic record of the use of torpedoes was in 1777, during the war between England and her American Colonies; various attempts were made by the Americans to destroy the English shipping, but these attempts were attended with little success. The subject then seems to have been forgotten for a period of twenty years, when a series of experiments were carried out by an Englishman named Fulton, who in 1804 inflicted some damage and caused a great deal of alarm, by means of drifting torpedoes to the French fleet lying in Boulogne Roads.

Fulton received a large sum of money from the English Government for his inventions, which at their best were very crude and imperfect; but chiefly from the insuperable objections to their use on the score of humanity, and the danger o handling them, they were never liked, and at the close of the war in 1815 dropped almost entirely out of sight.

Some few torpedoes were next used by Russia in 1854, in the Baltic, during the Anglo-Russian war; their submarine torpedoes inflicted but little damage, but some of their land mines, placed for the defence of their forts in the Crimea, proved fearfully destructive to the allied army.

It remained for the Confederates during the late civil war in America, at one bound to completely revolutionize the aspect of modern coast defence; by the introduction of a well-conceived and cleverly-executed system of torpedoes.

With a vast extent of coast peculiarly liable to attack, and with scarcely a ship to oppose the powerful navy of the North, the pressure of dire distress caused them to turn their earnest attention to the manufacture of torpedoes as a means of defence against such terrible odds; with the aid of their best engineers they were able within a very short period to form so complete a system, that the damage inflicted apon the Northern fleet by their means was materially greater than that caused by the whole of the heavy guns, mounted on the numerous forts, erected for the protection of their great seaport cities.

In Charlestown alone, the officers and men of the Torpedo Corps numbered upwards of 60, their duty simply being to lay down and work the torpedoes—all the necessary apparatus being made elsewhere. The practice of the Confederates was to keep a large supply of torpedoes of various kinds always on hand, and ready for immediate use; a careful survey of the water was made, and places likely to be passed over by the Northern ships secretly marked down on a chart; whenever an attack was threatened, the torpedoes were rapidly placed in position. In almost every case where an attempt was made to force a passage through a channel defended by this means, one or more of the attacking vessels were destroyed. Many of these vessels were heavy iron-clads manned by a large crew, and in some cases engaged at the very time of their destruction in attempting to discover and remove torpedoes which it was known were placed there.

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* Lecture recently delivered at Foochow by Mr. J. A. Betts, M.S.T.E., Director of the Imperial Torpedo College, Tientsin. It may interest readers to know that this lecture has been translated into Chinese, and copies sent to the different Viceroys and high officials throughout China.

One case in particular may be mentioned. The defence of the water approach to the city of Richmond was entrusted to electric torpedoes sunk in the bed of the river. With the patience of a spider watching for its victim, for thirteen months the Confederate officer in charge of these torpedoes remained waiting in a sand-pit on the river-bank for an opportunity to fire them with effect; at length the Northern fleet entered the river—the foremost vessel was allowed to pass over the first line of mines in safety (it being calculated that it would inflict most damage if the second and heavier ship was destroyed first), when an order was given for the ship to fall back, and send out her boats to drag for torpedo wires; as soon as this was observed from the shore, the officer determined to fire as she descended the stream. The explosion took place on a clear afternoon and was seen by several persons; the hull of the vessel was lifted right out of the water, her boilers exploded, her smoke-stack, upper deck, and crew were projected into the air with great velocity, and out of 127 men on board only three escaped alive; the vessel was literally blown to atoms.

The awfully sudden and complete destruction of this vessel so paralysed the rest of the fleet, that Richmond was, for the time saved. Thus, the successful explosion of one torpedo, at a cost of only a few pounds, annihilated a large vessel costing many thousand pounds, and kept a whole fleet at bay.

Apart from the actual damage done to the enemy, the moral effect produced is of incalculable service to the defenders. No captain will willingly lead his vessel into waters known to be infested with deadly volcanoes from which there is no escape. Brave men can always be found to face an open and visible danger, but it requires something more than bravery to ask men to advance in the face of a danger which cannot be seen and yet is known to exist; this was most clearly demonstrated during the late Franco-Prussian war. France, with one of the finest navies in the world—second only to England—was unable to effect one single victory during the whole of the war; indeed, her ships were never brought into action, solely through the moral effect engendered by a knowledge that the approach to every port on the Prussian sea-board was thickly studded with torpedoes. During a prolonged war the French fleet were from this cause compelled to remain totally inactive.

When properly devised and laid down, and worked by skilful operators, heavy guns and iron-clad vessels should both alike be powerless for attack against the destructive effects of modern torpedoes.

Torpedoes may be divided into two distinct classes—Electrical and Mechanical. The first comprises all those torpedoes in which the explosion is caused by an electric current controlled from the shore, whether brought into action from the contact of the vessel with the torpedo, or fired at the moment the vessel is passing, by an observer on the look-out. Mechanical torpedoes are those in which the explosion is caused by the concussion of the vessel with the torpedo—they are of many kinds, and should always be considered as only accessory to electrical torpedoes; once being placed in position, all control is lost over them, and they become deadly to friend and foe. The electrical torpedoes used by the English and American Governments (who are fairly entitled to be considered as at the head of the science), are of two kinds—viz., electro-contact torpedoes, and torpedoes fired by observation.

Each torpedo in itself consists of three parts, the fuse, the charge, and the iron torpedo case, together with the necessary electrical apparatus and wires, giving the operator on shore the entire control of the mine.

Electro-contact torpedoes are so placed that any vessel running into port must strike against one of them, the concussion of the blow being sufficient to set in motion the electrical apparatus; but it is here the beauty of this system comes into operation; should it be a friendly vessel running into port for shelter, the torpedo can, in an instant, be rendered harmless by the observer on shore, the ship striking the torpedo but producing no explosion; but when the vessel has passed the line of mines they can as instantly be rendered deadly engines of destruction, ready to destroy all whom the master hand may direct.

This torpedo can be placed at distances far exceeding the effective range of the heaviest guns. It is equally effectual in protecting a port by night or by day; and in thick fogs and misty weather, when a ship might run by a fort unseen, still keeps its silent watch.

As the torpedo is in actual contact with the vessel at the moment of explosion, its effect is most terrible, and much smaller charges can be used than in the system of firing by "observation." In this latter description of torpedo, heavy charges of powder, 500, 1,000, or 2,000 lbs., are fired at the moment a hostile vessel is passing over the place where the torpedo is submerged; this is accurately determined by two observers on shore, placed at different points and having telegraphic communication with each other. It is especially valuable in defending narrow channels and places where large vessels would anchor during the attack on a fort. By means of "telescopic observing arcs" the position of the ship can be determined to the greatest nicety, and the fire of the torpedo reserved until the ship comes within the "area of destruction."

Obstructions, such as sunken vessels loaded with stones, piles, floating booms, &c., can be formed, leaving only a narrow channel available for the passage of ships. This channel can be heavily defended by electrical torpedoes—leaving free communication for friendly vessels only. The obstructions themselves can be defended by mechanical torpedoes, and should if possible be commanded by the guns of some neighbouring fort. Small torpedoes may be placed and fired in groups of three, five, or seven, at points where it is likely that ships' boats would attempt to pass or land.

In combination with any system of electric torpedo defence it is of the utmost importance that good telegraphic communication, from point to point, should be established. Every fort or "look-out" station should telegraph to the next point information of the movement of any ships passing up the river or channel; thus, each fort or torpedo station would be prepared long before the enemy appeared, and every man would be at his post and under the control of his commanding officer.

Unless good provision is made for the transmission of such intelligence, half the value of a torpedo defence is lost. Underground wires should be used which would place them beyond the knowledge of the enemy. With an electrical system of torpedoes, one point of the greatest value is the power, day by day, of testing the working condition of each separate mine. By a proper routine of daily tests, it can be ascertained beyond the possibility of doubt that the torpedo itself is water-tight, and securely anchored, that the bursting charge is dry, that all the wires and electrical apparatus are intact and in good working order, and that the mine can be fired at any moment.

Again, electric torpedoes are in themselves non-explosive, and cannot explode by a fall or any careless handling; nothing short of the actual passage of the firing current can cause an explosion.

The electrical ignition of the torpedo has next to be considered, and upon the certainty and accuracy of this operation, the value of the torpedo itself entirely depends. Many appliances have been tried, but the British and American Governments have, after a long course of experiments, determined to use the "platinum wire fuse," fired by the "Silvertown Firing Battery," and in this determination they are undoubtedly right. The fuse is simple, safe, and certain, and can be tested electrically both before and after it is placed in the torpedo without the sligthest fear of explosion. This last fact alone should be quite sufficient to establish its value over all others.

The cable by which the electrical communication with the torpedo is maintained should be of the very best construction possible; thoroughly protected from injury by chafing over the rocky bottom of the river or sea in which it is submerged; care being taken that the place where it is brought ashore is hidden from view.

The charge itself may be either gunpowder, gun-cotton, or dynamite. The English Government use nothing but gun-cotton, and taking into consideration the fact that its explosive power, weight for weight, as compared with gunpowder, is four times greater, and that its purity and freedom from foreign substances, or any trace of acid, can be ensured, being manufactured by themselves, under the able supervision of the War-office chemist, Professor Abel, they are no doubt right. America and Sweden have been experimenting largely with dynamite, a preparation of nitro-glycerine, possessing, roughly stated, an explosive force eight times greater than ordinary gunpowder. Prussia, during the Franco-Prussian war, used "dauline," a fearfully-explosive nitro-glycerine preparation. Austria, during the Austro-Italian war, used gun-cotton, with marked success.

If it were possible to entirely depend upon the purity of gun-cotton, and the care with which it had been manufactured—which we cannot do—there are many reasons why it should be used; but, all things considered, foreign countries in which the explosive employed is not manufactured by their own Governments are wise in retaining the use of ordinary gunpowder.

Mechanical torpedoes are of many kinds, much ingenuity having been shown in their manufacture during the American civil war. They should only be used as flank defences, or in conjunction with floating or submerged obstructions; the main defence always being intrusted to electrical torpedoes; as, where mechanical mines are used, the place is closed alike to friend and foe, they are exceedingly dangerous to handle and place in position. Many lives were lost by accidental explosions during the Franco-Prussian war among the officers and men of the Prussian torpedo engineers, when engaged in blockading the mouth of the Elbe; and at the close of the war, when it became necessary to again open the river for navigation, a further series of lamentable accidents took place during their removal. But they did such service to the Confederate forces, and worked such havoc among the Federal fleet, destroying upwards of twenty large vessels, that it would be very bad policy to ignore them altogether. One of the best of their kind is that known as "singers." This is a buoyant torpedo, securely anchored beneath the surface of the water; it is provided with a false iron lid, or cover, which falls off when struck by the passing vessel, firing an ordinary friction fuse, inserted in the bursting charge, in its fall.

The explosive property of sulphuric acid has been utilised in many ways. One torpedo is so constructed that a glass tube containing acid is broken by the blow from the ship, and falling on an explosive mixture of chlorate of potash, generates sufficient heat to instantly fire the charge. Other torpedoes are so made that on being struck by a vessel, a metal plunger is released and a percussion-cap fired, in much the same manner as on a rifle; this kind was largely used by the Confederates, and one of them, which had broken loose from its mooring, and drifted away, struck and sunk a vessel entering one of their ports, more than two years after the close of the Civil War.

Electrical torpedoes have so far supplanted mechanical, that it is useless to speak of the many ingenious plans devised at various times, all good in themselves, if we had not something better in the application of electricity to this science.

(To be concluded.)

The Rio Grande do Sul and Monte Video section of the Western and Brazilian Telegraph Company's Cable was repaired on the 24th ult. The West India and Panama Telegraph Company's cable between Santiago de Cuba and Jamaica has been interrupted.

THE RADIOMETER AND ELECTRICITY.

THE phenomena presented by this curious little instrument have awakened a lively interest on both sides of the channel, and though observations have been numerous, it can hardly be said that we have learned all from the radiometer that it is able to teach us. We recently referred to some interesting experiments by a Belgian observer, M. Delsaulx, who considered he had found in electricity the cause of the radiometer's motion, both direct and inverse. Prof. Stroumbo, of Athens (we learn from *Les Mondes*), has been experimenting in the same direction. Among other arrangements he constructed a radiometer having three platinum wires (which terminated in copper discs) soldered into the glass envelope of the instrument; two were on one side—viz., Disc A above the vanes and B below them; the other disc, C, on the other side, and below the vanes. A lighted candle being brought near, rotation occurred in the usual way from B to C. The candle was then put out, and when the radiometer had come to rest, a current of 3 or 4 elements was connected with a Ruhmkorff coil, and the extremities of the fine wire were connected, the positive pole with B and the negative with C. The radiometer then turned in the same direction as before. If, while it is turning under the influence of electricity, a lighted candle be brought near, the rotation is considerably increased. Thus the actions appear to be in the same direction.

While the radiometer was turning under the influence of a gas flame, the wires and discs B and C were connected with a galvanometer. The needle was deflected through an angle of 5°, and the effect would probably have been greater with a more delicate instrument. The radiometer took the same motion of rotation when the positive pole was connected with A, and the negative with C. On the other hand, if the poles be reversed, the positive being connected with C and the negative with B (or A), the radiometer does not turn any more. If the positive pole was connected exteriorly with the top of the instrument, or its base, while the negative was connected with C, no motion occurred. Several other effects which M. Stroumbo obtained on applying his fingers to the glass support of a radiometer, rubbing the envelope circularly with silk cloth, pouring ether on it, &c., are connected by him with electrical influences.

In a recent paper to the Royal Society, Mr. Crookes called attention to some curious phenomena exhibited by a small piece of pith hanging down like a pendulum towards the rotating vanes of the radiometer, and about a millimetre distant from these. It was noticed that scarcely any movement of the pendulum occurred when the rotation was very rapid; but at one particular velocity the pendulum set up a considerable movement. At the suggestion of Prof. Stokes, the candle which produced the rotation was placed at the distance from the radiometer, for which a revolution of an arm of the fly synchronised with a vibration of the pendulum. In this way the pendulum was kept for some time swinging through a large arc.

Prof. Challis, in his study of the radiometer (*Philosophical Magazine*, November, 1876), has seen reasons to conclude that the light or heat in a radiant form, incident on the vanes, has the effect, after being transformed into heat of temperature, of so changing the relative positions of the atoms in a superficial stratum, as actually to induce the electric state. With this assumption, he proceeds to account for the phenomena described by Mr. Crookes. Since the radiant light or heat is converted into heat of temperature in a greater degree on the blackened surface of a vane than on the other, the two surfaces are electrified in different degrees, and relatively to a neutral state one is positively electrified, the other negatively. A face of the vane, whether positively or negatively electrified, will, on approaching the piece of pith, *attract* it; and the oppositely electrified face of the same vane, after passing the pith, will also attract it, supposing there is no contact between the vane and the pith. Thus the piece of pith is drawn in opposite directions in quick succession, if the rotation of the vanes be very rapid; and if impression of motion takes time, it might well happen that under these circumstances no perceptible motion takes place. If, however, the rotation is slow, the attraction of the vane in one direction may take effect before that in the opposite direction commences, in which case an oscillatory motion of the pithball will be produced. Clearly the oscillations will be most steady when by reason of synchronism of the time of oscillation of the pith with the time of revolution of the vane the attraction of a given vane acts like gravity on a pendulum. If the oscillations were due to action of the vanes on residual air, it seems hard to understand why there should be no perceptible effect when the rotation is very rapid.

No motion occurs in a radiometer before exhaustion of the globe, and the reason (according to Prof. Challis) is, that no electricity can pass, air of ordinary density being a non-conductor. On producing exhaustion, the rotation commences and increases up to a certain point, because rarefied air is a conductor of electricity. After a high degree of exhaustion is attained, the rate of rotation diminishes, because vacuum is a non-conductor of electricity, and an approach to that condition has a retarding effect. The vane continued to move when the degree of exhaustion was considerably greater than that at which the spark ceased to pass under the particular conditions arranged for the comparison.

Notes.

THE free scientific lectures in connection with the Loan Collection have been resumed. On the evening of Monday, the 6th inst., Prof. Adams lectured on the mirror as an instrument of scientific research; describing, *inter alia*, Wheatstone's method of determining the velocity of electricity, and exhibiting the apparatus.

At the opening meeting of the Physical Society on the 4th November (Prof. Foster presiding), Dr Guthrie read two letters from M. Forel, on the subject of formulæ for the "*seiches*" or periodic oscillations on the Swiss lakes. Dr. Stone exhibited some diffraction gratings on glass and metal, ruled by Mr. Clark, of Lower Norwood; they contain 1,000 lines to the inch and give spectra of great brilliancy. Dr. Guthrie described some experiments he had made to determine the effect of a crystalloid on a colloid, when in the presence of water. Two or three lumps of rock salt having been added to a jelly of size, and the whole hermetically sealed in a glass tube, the colloid parted with its water readily, a saturated solution of the salt was obtained and the size became perfectly white and opaque, having undergone a structural change.

Since the first of March last, the telegraph authorities in Germany have required their messengers, when delivering a telegram, to take back to the office, if requested to do so, any telegrams in reply or otherwise, and a recent report states that this arrangement has worked sufficiently well to justify its being permanently continued. The public, indeed, has not very widely taken advantage of these facilities, probably through defective knowledge of them; accordingly by a fresh order just issued, the messenger, on delivering a telegram, is to ask the receiver politely whether he or other inmates of the house have telegrams to send. It is expected, the Report adds, that the public will recognise and accept such an inquiry as a special accommodation on the part of the authorities.

Professor W. A. Anthony, in the course of a recent series of experiments with an electromagnetic machine of the Gramme pattern, made the following interesting observations:—The electric machine was driven by a five-horse Brayton petroleum oil-engine. The engine consumed a little over six-and-a-half lbs. of crude petroleum per hour. The lamp used in the engine, by which the explosive mixture is fired, had a one-inch flat wick, and consumed 29·8 grammes (459 grains) of oil per hour. The power resulting from the motion of the engine, when applied to the electric machine, produced a stream of electricity or electric light having an illuminating power equal to that of 234 of the lamps mentioned, showing that three times more light may be produced from a given quantity of oil, if its energy is converted first into mechanical power and then into electricity, than if the oil is directly burned in a lamp.

A new hypothesis as to the nature of electricity (we learn from *Stummer's Ingenieur*) has been offered by Prof. Renard, of Nancy. He considers an electric current to be produced by longitudinal motion of the ether-particles, which, at the same time, have a *general* forward motion. When the molecules of a body are surrounded by a greater ether-atmosphere than the normal, the body is in the condition which we call positively electric; when the ether-atmosphere about each molecule is less than the normal, the body is negatively electric. He has sought to explain various electrical phenomena thus: for example, the magnetisation of steel needles by electrical discharges; regarding which Savary has shown that, according to the position of the needle, it acts in one direction or the other.

In the German Reichstag, last week, complaint was made of the high telegraph charges between Berlin and London. If the difficulties raised by Submarine Companies are not speedily reduced, the English and German Governments will take the matter in hand, and lay a cable at their own cost.

Mr. Edwin Clark, the eminent engineer, has recently been paying a visit to Buenos Ayres and other parts of South America. The *Tribuna*, in recounting his numerous achievements, informs its readers that he is the constructor of the Menai, Conway, and Victoria bridges, the Chelsea suspension bridge, and the Crystal Palace!

The wire of the Pagoda Telegraph Line having been repeatedly cut and stolen, the Foochow Board of Foreign Trade have issued a proclamation, which is rather a curious and characteristic document. "These fellows," it says, "really show an inveterate and detestable love of mischief. Although telegraphs are a foreign invention, still the line has been purchased by the Government, is managed by the Government, and is Government property. The law shows no leniency to those who steal goods belonging to the Government." Telegraphs are further affirmed to come under the heading of war material, being used for transmitting military intelligence, and people stealing war material are subject to more rigorous punishment. The authorities might seize and punish instantaneously, but cannot bear to put to death those who have not been instructed, therefore again make solemn proclamation, &c. "All of you were originally good, how is it that you do not possess any self-respect?" Fathers must warn their sons, and elder brothers constrain their younger ones, so as to prevent wilful violation of the laws. Should people be met with stealing the wire, they are to be seized, tied up, and, together with their booty, handed over to the local authorities for trial. If proved guilty, they will be executed on the spot, as a warning to others. For the apprehension of one thief a reward of 200 dollars is offered. "It will be impossible to show mercy hereafter. Let everybody ponder over this three times, that he may have no occasion for repentance afterwards. Tremble and obey!"

The telegraph-lines of Austria had, at the end of 1875, a length of 33833·44 kilometres, as against 31731·79 kilometres at the end of 1874. The length of the wires was 84833·99 kilometres against 82718·80 kilometres at the end of 1874. The number of telegraph stations opened for traffic in 1875 was 113, raising the entire number of stations to 946. There were altogether, 3,195,505 telegrams handed in as against 3,101,711 in 1874. The number received was 7,419,870 against 7,289,866 in 1874. The entire number of telegrams treated was 14,136,097 against 13,792,557 in 1875. The total receipts of State telegraphs amounted to 2,552,327fl. against 2,419,035fl. in 1874 (an increase of 133,212fl.). The expenditure amounted to 3,376,409fl. against 3,470,075fl. in 1874 (a decrease of 93,666fl).

Some interesting particulars of the history of Mr. Townsend's giant chimney in Glasgow (which is 454 feet high) are given in *Iron* of October 28. The chimney has been repeatedly struck with lightning, and the proprietor, impressed with the necessity of making some material change in the system of protection, has adopted the following arrangement: On the top of the coping-stone are fixed four equi-distant rods about three inches wide and one inch thick; these terminate in stars or arrow-heads, and above them, in the centre, ascends a rod twenty feet long, and higher than the rest, terminating in a double arrow-head. All these are properly connected with bands of iron, and placed in good communication with the electrical conductor and the coil below. The coil joins the conductor near the ground, and both are bound with an iron rod ten feet long, passing eight feet into the earth. The lower part is tallowed, and enclosed in a wooden box.

The destruction of oil by lightning this year, in America, has been remarkable, amounting to 242,412 barrels, from January 1 to July 31 of this year, or rather from April to August; there were no fires from this cause in January, February, or March; two in April, none in May, four in June, and five in July. The oil destroyed is in closed-top iron tanks, and the lightning, striking these, explodes the gas that collects in the space above the oil, scatters the oil, and sets it on fire, and in this way often communicates to other tanks in the immediate vicinity. The theory most commonly received in the oil regions of the cause of such frequent lightning-strikes is that the gas, which, it is well known, is continually escaping from the oil in these tanks, rises to some distance above the tanks, acts as a conductor, attracts the lightning, and the damage is done. (This view seems doubtful). One peculiar feature in the history of these accidents is that, so far as is known, no iron-topped tank has been struck, but in every case wooden-topped ones. Attempts to protect tanks with lightning-rods have hitherto been failures; at Dilks' Station, a number of rods, supposed to be ample protection, were placed about the tanks, but they were no protection against this summer's bolts.

In reply to an inquiry by Mr. Prescott, of the Western Union Telegraph Company, as to underground lines in the Dutch East Indies, M. Malphen states that, correctly speaking, no underground lines exist in India, unless the ends of submarine cables which, after leaving the water, are carried underground to the offices, may be so called. The lengths of these ends are as follows:

Singapore Cable, near Batavia	3½	miles.
Port Darwin Cable, nr. Banjoewangie	½	,,
Java Cable, near Anger	⅕	,,
Sumatra Cable, near Telok Betong ...	1⅐	,,

They are laid in the vicinity of the cities, but not in the cities themselves. They are ordinary deep sea cables insulated either by gutta-percha or india-rubber. Some of these sections last four years and none longer than five. They are very liable to injury from white ants. These insects penetrate through the crevices of the wire armour and eat their way through the hemp covering saturated with tar, and through the gutta-percha, to the core. India-rubber resists them somewhat better. Pneumatic arrangements for forwarding messages through the tubes laid underground do not exist in India.

The current number of the *Philosophical Magazine* contains papers "On a Method of Measuring the Contour of Electric Waves passing through Telegraph Lines," by Mr. Sabine; "On a Model illustrating mechanically the Passage of Electricity through Metals, Electrolytes and Dielectrics, according to Maxwell's Theory," by Mr. Lodge; and "Theoretical explanations of Additional phenomena of the Radiometer," by Prof. Challis.

The Indo-European Telegraph Company's cable between Penang and Singapore is reported to be working badly ,necessitating a special steamer. Average time in transit between London and India of all outward messages, week ending October 6th, 43 minutes; 13th, 38 minutes; 20th, 37 minutes; 27th, 35 minutes.

The incident of General Newton's little girl pressing the key of the batteries by which the recent explosion was effected at Hell Gate, is by no means a bad subject for the poet. To what heights the American muse can soar on fitting occasions will be evident from the following, which has appeared in the New York *Graphic* :—

Infunt, awl hale! You air a
Hole team and hos under th' waggin. I
Like your stile. Say, tel me how you phelt,
Thou micoskopic maden, wen you put
Thi thum—O tender thum!—uppon th' peddle
Of the magnetico-illectrico batry and receaved
Th' awful shock of hitherto incarcerated
Lightnings throughought your infantile system.
Then rousing to the efort hurled them
Back till the blast went awff and water flue
Up hire than th' hen house!

Then, alass!
I dust not dout thou thaut of uther seens—
Franklin with pretzel underneeth his arm
Trolling for lightning over in New Jersey,
Morse eting mush and milk on bord th' sloup, and
Tops auf with sossages and cheas and hies
Him to his bunk an' dreems immortle dreemes.
Of Tomassen or Thompson, who exspired just as he
Showwed (alass) th' value o' his grate invension.

Prekotious child!
Thou canst relait unto your ancesters in
Future years how you fixed th' jografy
And wiped out Hell Gate. Wen tha ask thee, child,
Hoo cood hev moved that mity rok? you kin
Exclame with pried, "I dun it—it was me!"

O Newton, watch thi child. Nourish her. Tend to
Her. Let her doo as she's a mind ter. Ef
You don't thou ain't the' man i touck you phor.

NOTES OF TRAFFIC RECEIPTS.

Great Northern Telegraph Company, for October, 548,647 francs; (last year, 386,659 francs). Total, January to October, 4,162,322 francs; (last year, 386,659 francs). Total, January to October 4,162,322 francs, (last year, 3,509,746 francs).

Direct United States Cable Company, for week ending 28th October, £,3,653; 4th November, £,3,620.

Direct Spanish Telegraph Company, for October, £781, against £,1,580 same month last year.

Cuba Submarine Telegraph Company, number of messages in October, 2,113, estimated to produce £1,303, against 2,372 messages, producing £1,977 in same month last year.

West Coast of America Telegraph Company, for four weeks ending 26th August, £2,449.

Anglo-American Telegraph Company, 4th November, £1,560; 5th, £500; 6th, £1,260; 7th £1,740; 8th, £1,320.; 9th, £1,630.

Eastern extension, Australasia and China Telegraph Company, for October, £18,465 (against £19,604 in the same month last year).

Electrical Science in Foreign Journals.

COMPTES RENDUS OF PARIS ACADEMY.

No. 16: 16TH OCTOBER, 1876.

On the Carving Action of Acids on various Metals. By MM. TREVE AND DURASSIER.

UNDER certain conditions, the figures on the metal are related, not to the interior structure, but to the exterior action of gas-bubbles liberated. Studying the interior magnetism of magnets, the authors placed a horse-shoe magnet, heel down, at an angle of about 45°, in a bath of water acidulated with sulphuric acid (the half was immersed); and daily compared the loss of coercitive force with that of weight. On the sixth day, wishing to accelerate the action, they added an equal quantity of nitric acid. In the evening, the immersed part was found carved in a very fine and curious way. At the heel, the hollowed curves were perpendicular to the axis of figure, and they took the form of screws in rising up the branches of the magnet. If the magnet be wholly immersed flat, all the lines are normal to the axis of the figure. If the bath contain no nitric acid, the attack is longitudinal along the fibres of the metal, whatever the position in the bath. Like effects were had with other metals.

Comparative Influence of Leafy Trees and Resinous Trees on the Temperature and Ozonometric State of the Air. By M. FAUTRAT.

IN woods, especially of resinous trees, there is less ozone than on open ground, and the atmosphere contains more of it, in them, at 14 metres from the ground, than on the surface.

No. 17: 23RD OCTOBER.

Note on Electric Effluves. By M. BOILLOT.

HE indicates slight modifications of the apparatus we have already described (page 226); *e.g.*, the distance between the graphite tubes can be varied, so that, with a certain distance, there is no phosphorescent glow between them in darkness.

On the Electrical Apparatus of the Torpedo. By M. ROUGET (second note).

HE describes the structure, which he has minutely examined. (See below.)

No. 18: 30TH OCTOBER.

On a New Electric Lamp devised by M. Jablosckkoff. By M. DENAYROUZE.

ALL the ordinary mechanism is suppressed. The two carbons are fixed parallel, and held a small distance apart by an insulating substance, which disappears along with them. The voltaic arc is formed between the two free ends of the carbons, and under it the insulating matter is fused and (partly) volatilised, disappearing like the wax of a candle. Various insulating substances may be used—sand, glasses, mortars, lacs, &c. The one provisionally adopted as simplest and cheapest is formed of sand and pounded glass. The light from incandescence of this matter gives effects like those of the Drummond light. The inventor can also divide the electric light from one source; working three lamps at once from a single Gramme machine.

On the Distribution of Magnetism on the Surface of Magnets. By MM. Treve and Durassier.

The authors claim for their direct analytical method in studying the magnetism of steel the advantage of not involving rupture of the metal, as in the common method, that of measuring the resistance of the matter to traction. They give curves obtained for surface magnetism, determined by the method of detachment. The more carbon a steel contains, the more is the magnetism condensed towards its extremities; the less carbon, the more is the magnetism spread out equally over its surface. M. Schneider is preparing, for the authors, a new series of steels hardened in cold water, and they wish to formulate a simple law for the relation between the coercitive force of these steels and their proportions of carbon. The law seems simple, when the results from extreme steels, whose purity is not doubtful, are compared; and if it is not so clear for intermediate steels, this is probably due to small quantities of foreign elements, silicium, phosphorus, manganese, &c. It may even be hoped (from the nature of this perturbation) that the magnetic analysis of steels will indicate to metallurgy what are the weights of these other substances capable of giving to a steel the same physical properties as a determinate weight of carbon.

On the Electric Apparatus of the Torpedo. By M. Rouget. (Third Note.)

Besides the ramifications of the nerve fibres and of the reticulated nervous plate, in these organs, there is nothing but vessels and cell elements, fibrillæ and membranes, all belonging to connective tissue. The nervous elements alone belong to the category of organic formations (muscles and nerves), in which is observed a development or rather transformation of force. In the reticulated nerve-plates, where neither motion nor sensation is manifested (forms of force occurring elsewhere), nearly the whole of the potential energy (neurility) accumulated by nutrition in the terminal nervous system is transformed into electricity.

Variations of the Electric State of Muscles in the Tetanus produced by Passage of a Continuous Current, studied with the aid of the Induced Contraction. By MM. Morat and Toussaint.

In such tetanus, the electric state of the muscle is sensibly uniform throughout the contraction; the induced contractions (shocks isolated or associated in a tetanus of short duration) are to be regarded as accidents (the cause of which does not appear from comparison of the two tracings inducer and induced).

Les Mondes—5th October, 1876.

Circular Motion produced by Action of Two Magnets. By M. Stroumbo, of Athens.

He accomplishes this as follows:—A magnetic needle is pivoted so as to be capable of rotating in a vertical plane; its horizontal axis is turned by means of a wheel and handle. Another and similar needle, at a slightly lower level, is pivoted near, and almost in a line with it; the two needles overlap each other a little, with unlike poles. As the end of the motor-needle moves down towards the vertical, that of the second needle does the same. Then the other two opposite poles begin to attract each other as the first pair retire. Both needles thus come round to the horizontal position again, and the motion is repeated.

New Experiments with the Radiometer. By M. Stroumbo. See page 296.

Monatsbericht of Berlin Academy.

May, 1876.

Preliminary Communications on Electric Discharges in Rarefied Gases. By M. Goldstein. See page 000.

On the Excitation of Electricity by Friction. By M. Riess.

Little has been known of the laws of this common action; owing greatly, doubtless, to the inconstancy of the phenomenon, since two bodies rubbed together do not always become charged with the same electricities, and probably, through slight changes in the nature of the surface, the electricities become also changed, without the cause being apparent. M. Riess here collects what is known on the subject, and adds observations of his own. He illustrates the following propositions:—1. In excitation of electricity by friction, there are always two electricities produced. 2. Of the two, there are perfectly equal quantities. 3. If two surfaces of equal size are rubbed together, then so long as they cover each other, neither of the two electricities can be conducted away. 4. In friction of surfaces of different size, the rubber receives a greater quantity of electricity than a portion of the rubbed surface equal to it; and while the rubber is applied to the surface, the excess of electricity which it possesses may be conducted away. 5. By continued friction, there is the less electricity excited, the greater the previous friction. 6. In two previously electrified surfaces, friction produces a less quantity of electricity than if the one surface is unelectric.

June, July.

No papers on electrical subjects.

Journal de Physique.

October, 1876.

On the Optical Composition of Rectangular Vibratory Movements of any Period and Phase. By M. Mercadier.

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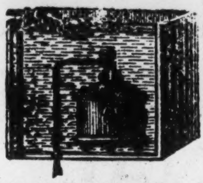

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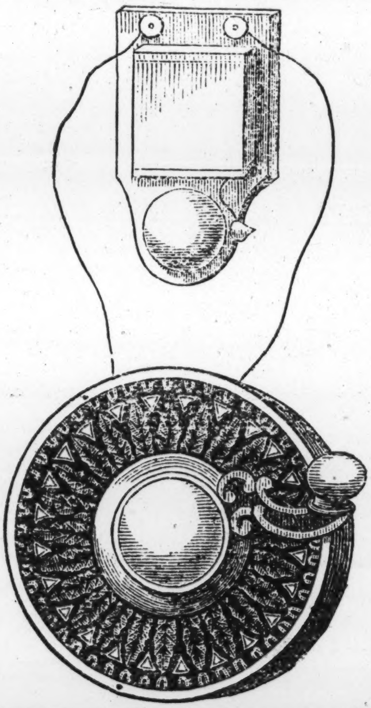

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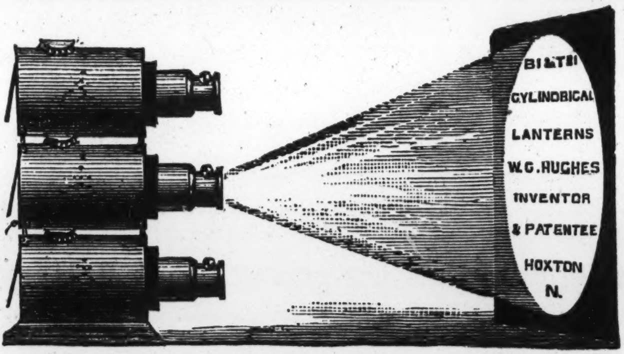

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